search   current discussion   categories   technology - software

heatwork-calculating software (rocket science stuff)

updated wed 4 aug 04

Jim Murphy on tue 27 jul 04

Hello all,

Since a number of recent Clayart discussion topics have been geared toward
the science of "how things work" I thought I'd throw another important
associated question into the mix.

"Heatwork measurement" seems to be pretty darn important to the "science"
and "control" (I know, I'm feelin' a bit daring today) of creating and
hopefully re-creating extraordinary new glazes and/or clay-bodies.

Pyrometric cones, kiln-sitters, or just plain old "Gut-feeling alone"
certainly each have their own merit.

But how about those times when we're just NOT sittin' there for the complete
firing cycle ? What "real" heatwork was performed ?

You know, maybe we go pickup the kids at school, go to a ballgame, grill
some steaks, take a much needed rest, or cleanout the dog kennel (just
funnin' witcha Mel!).

It's during those times we're away that we may miss an important unrecorded
"event" - an unplanned short-term "increase" or "drop" in the kiln's

internal temperature - perhaps altering the overall heatwork of
the firing
cycle.

This short-term event may be the result of dark clouds passing
by, or the
dog chewing into the kiln-wiring and creating a temporary
"short-circuit",
etc.

After firing, how accurately can we each really "read" those
cones anyway ?
It would be nice to have a more accurate plot or "visual
record" of the
heatwork actually performed.

For digitally-controlled kilns, I know there's some KISS (Kiln
Interface
Software System) "software" available that will ONLY plot
temperature versus
time.

What I'm looking for is a lead on where to get KISS
"software" that along
with a computer will "plot" temperature vs. time AND also
calculate the
actual heatwork (the "area" under the temp/time curve) for the
firing
cycle.

Anyone have a lead for KISS software that will also calculate
the heatwork ?

Best wishes,

Jim Murphy

Ivor and Olive Lewis on wed 28 jul 04

Dear Jim Murphy,
Perhaps a good place to start is to sort out the tautology
encapsulated in the term "Heat Work".
Beat regards

Ivor Lewis.
Redhill,
S. Australia.

.

mailtoandrew@FSMAIL.NET on wed 28 jul 04

Hello Jim,

I can=92t advise on any suitable software but have you
considered using
Bullers rings? If you don=92t know what these are, and
apologies if you do:

They are flat hollow centered rings with an approximate
diameter of 65
millimeters whose contraction in principle is proportional to
the heat
work experienced. After a brass gauge is used to measure the
firing the
contraction, the graduations being arbitrary numbers that are
used to
describe the firing regime experienced.

Four types are produced, the only difference being the
material
compositions, that cover temperatures from 960 to 1420 oC
(1760oF to
2580oF)

Advantages over cones include:

Only a single type is needed for a firing, for example type 27
rings
cover 960 to 1250oC (1760 to 1250oF)
Measure the heat work of the firing whether a potter is
present or not
Are accurately measured by a precision device
Are arguably better at measuring heat work than cones

My only cautionary note is about the concept of heat work.

Care should be
taken with this notion as heat work has no units and is not a precise
measure of anything. However it is easy to understand and works well in
production environments.

Further information about the rings can be found at
http://www.taylortunnicliff.co.uk

Regards,

Andrew

George Koch on wed 28 jul 04

Hi Jim,

I've been noodling this also for a while. I've got the KISS software and
plot the temp/time line all the time, and would also like to calculate the
area under the curve, but it strikes me that I'd probably have to make the
x-axis up at somewhere between 1000 and 1600 degrees, since (I think) no
effect is had from the heat work until the glaze is melted. If I choose the
wrong temp for the x-axis, then I get a constant added or substracted to
every calculation, which may throw off any conclusions I can draw. Surely
this has been done in ceramic science somewhere.

If you get any good insights into this, I'd love hearing them.

George+

Rev Dr George Byron Koch, Pastor (and Potter) .
Church of the Resurrection .
West Chicago IL 60185 .
www.resurrection.org .

Isaiah 64:8b We are the clay, and you are the potter. We are all formed by
your hand.

-----Original Message-----
From: Jim Murphy [mailto:nomocor@COMCAST.NET]
Sent: Tuesday, July 27, 2004 11:31 AM
Subject: Heatwork-Calculating Software (Rocket Science Stuff)

Anyone have a lead for KISS software that will also calculate the heatwork ?

Best wishes,

Jim Murphy

Jim Murphy on wed 28 jul 04

on 7/28/04 10:27 AM, George Koch at georgekoch@GEORGEKOCH.COM wrote:

<< ... but it strikes me that I'd probably have to make the x-axis up at
<< somewhere between 1000 and 1600 degrees, since (I think) no effect is had
<< from the heat work until the glaze is melted. If I choose the wrong temp
<< for the x-axis, then I get a constant added or substracted to every
<< calculation, which may throw off any conclusions I can draw.>>

Hi George,

First, let me say I'm looking for software to supplement Cones or Bullers
Rings.

I think the heatwork "experienced" by a grain of kaolin, feldspar, silica,

etc., during firing is extremely complex and cannot be accurately
quantified. That type of heatwork is too complex. That's where you'll run
into trouble trying to determine where to place your X-axis points,
especially for different "firing profiles" and different glazes.

Whatever is calculated from the plotted time-varying "firing profile" should
be a reference measure of the kiln's "heatwork delivering capability". It's
kinda like with electricity, where "power" is delivered to a "load". In our
case, the "load" would be X-number pots + X-number kilnposts + X-number
shelves. We control the "load" by what we put in the kiln for each and every
firing. We also, hopefully, control the kiln's "firing profile". Just
substitute "heatwork delivering capability" for "power".

Our firing profiles are time-varying waveforms - temperature versus time.
Some "segments" involve a temperature rise while other segments involve a
fall in temperature.

I know I mentioned "area" under the curve in my original post, but - now
that I've slept on it - mathematically, the calculated root-mean-square
(rms) value of the plotted time-varying "firing profile" would be the
reference measure we're after - the kiln's "heatwork delivering capability"
or just simply the "kiln's heatwork" performed.

Again George, I wouldn't do anything "funny" with the X-axis points. I would
calculate the rms value of each curve from "t=0" until "t=?", where "?" would
correspond to your predetermined kiln-opening reference temperature
(preferably the same temperature for repeatable firing results AND

calculated reference measure purposes).

As long as the "load" is properly controlled each time for
similar firings,
the calculated "kiln's heatwork" reference measure would be
of significant
value.

By the way, if your KISS software can automatically plot the
temp/time curve
on a computer display - in "real-time" - please let me know
the name of the
software.

Best wishes,

Jim Murphy

Jim Murphy on wed 28 jul 04

on 7/28/04 2:41 AM, mailtoandrew@FSMAIL.NET at
mailtoandrew@FSMAIL.NET
wrote:
=20
<< I can=92t advise on any suitable software but have you
considered using
<< Bullers rings? >>

Thanks Andrew,

I have read about these rings before, but, haven't used them
yet.

For now, I'm satisfied with cones but wish to supplement them
with a
"real-time" recorded temp vs. time curve for each firing to
monitor my
"kiln's heatwork" performance.

More of my heatwork psycho-babble in my reply to George.

Best wishes,

Jim Murphy

John Hesselberth on wed 28 jul 04

Hi George, Jim and others,

It is interesting to me that the term 'heat-work' rarely is used in the
more technically oriented ceramic texts. One place it does occur is in
Singer and Singer's Industrial Ceramics (I have the English version
first printed in 1963 and reprinted in 1979). They even have sections
titled "Temperature and Heat-Work Measurement" and "Thermoscopes or
Heat-Work Recorders". In this latter section, though, there are no
equations. Rather they talk about pyrometric cones, Holdcroft's Bars,
Watkins Recorders, and Bullers Rings.

It could be that Orton has worked out algorithms for heat-work. I
believe some of the software for their controllers is patented based on
their ability to program in a 'Cone-Fire'. Therefore a search of the
patent literature might give some hints as to how they approach the
issue of calculating heat-work from time-temperature measurements.

Regards,

John
On Wednesday, July 28, 2004, at 11:27 AM, George Koch wrote:

> Hi Jim,
>
> I've been noodling this also for a while. I've got the KISS
software

> and
> plot the temp/time line all the time, and would also like to calculate
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> area under the curve, but it strikes me that I'd probably have to make
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> x-axis up at somewhere between 1000 and 1600 degrees, since (I think)
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> effect is had from the heat work until the glaze is melted. If I
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> wrong temp for the x-axis, then I get a constant added or substracted
> to
> every calculation, which may throw off any conclusions I can draw.
> Surely
> this has been done in ceramic science somewhere.
>
> If you get any good insights into this, I'd love hearing them.
>
John Hesselberth
http://www.frogpondpottery.com
http://www.masteringglazes.com

Lee Love on thu 29 jul 04

The best indication of "heat work" IMHO, is pulling glaze test tiles or
rings. When you look at a sample of the fired glaze, you can see
exactly what level of maturity the firing has achieved. Again,
this is a comparison of theoretical analysis and direct empirical
data.

Empirical *emÂ·pirÂ·iÂ·cal*:

Adjective Derived from experiment and observation rather
than theory.

--
Lee in Mashiko, Japan http://mashiko.org

http://www.livejournal.com/users/togeika/ WEB LOG
http://public.fotki.com/togeika/ Photos!

Jim Murphy on mon 2 aug 04

on thu 29 jul 04 Lee Love at (Lee@MASHIKO.ORG)
wrote:

<< The best indication of "heat work" IMHO, is pulling glaze
test tiles or
<< rings. When you look at a sample of the fired glaze, you
can see
<< exactly what level of maturity the firing has achieved.
Again,
<< this is a comparison of theoretical analysis and direct
empirical data.

<< Empirical *em=C2=B7pir=C2=B7i=C2=B7cal*:

<< Adjective Derived from experiment and observation rather
than theory. >>
=20
Hi Lee & others,

Well-said Lee.

For those using computer-controlled kilns though, it sure
would be nice to
have a better "tool" to help quickly adjust firing profiles
without
sacrificing "applied" heatwork.

If I understand heatwork like I "think" I understand heatwork,
then - in
accordance with "thee literature" - it's "possible" to apply the
same amoun=
t
of heatwork using different "firing profiles" (firing schedules).

Let's say you're experimenting with a new Crystalline Glaze or
Clay-Body
recipe but things just aren't working out right.

You think you're onto something though. You believe your material recipe is
fine because your last Crystalline Glaze firing was quasi-successful,
resulting in "perfect, octagonal-shaped Purple-colored macrocrystals with
Orange inclusions", BUT, most of the crystals slid off the pots. Or, your
last quasi-successful Clay-Body firing resulted in "a Basaltware-like body"=
,
BUT, there was just too much slumping.

Now, you could try the "gut feel" approach to adjusting temperatures and/or
hold-times in an effort to improve glass-phase viscosity, BUT, that may
alter the amount of heatwork applied, jeopardizing the crystals' shape &
color, or jeopardize the "look" of the desired "Basaltware-like body". Afte=
r
many more test trials and cursing-the-day-you-were-born, you may finally tr=
y
altering the material recipe, then you're back to "Square 1".

Perhaps, heatwork "theory" could be put to good use by adjusting the firing
profile for "longer firing times and lower maximum temperatures" [to improv=
e
glass-phase viscosity] and yet maintain the same amount of heatwork as the
original quasi-successful firing.

One could conceivably use the pyrometric witness Cone "visual recording" an=
d
plotted temp vs. time "curve" from that 1st quasi-successful firing - and
along with a little "heatwork mathematical wizardry" on that curve - quickl=
y
devise a modified firing profile [using software "on the

desktop"] to
significantly minimize the number of subsequent test trials
needed.

With a little luck (developed skill?), perhaps the VERY next
firing may
result in all the "perfect, octagonal-shaped Purple-colored
macrocrystals with Orange inclusions" remaining on the pots,
or the
"Basaltware-like body" coming out beautifully with no
slumping.

Being able to quickly devise adjusted firing profiles (e.g., heat-
rise,
cooling, hold segments) and yet maintain the same measure of
"heatwork" may
reduce number of test trials needed, reduce wasted raw
materials, reduce
energy used (less test trials), prolong kiln element-life (again,
less test
trials), yada-yada-yada.

More "good stuff" out of our kilns each time !

As the ancient Greek Philosopher, Logicus Reasoneus, once
asked, palms-up and shoulders shrugged.> "What good is
'Pure Science' if we do not
apply it ???"

[For those who just shouted, "Pure Science !" - then spit on
the ground -
you probably shouldn't have read this message.]

Now, to find or create that software !

Best wishes,

Jim Murphy

Ivor and Olive Lewis on tue 3 aug 04

Ear Jim Murphy,
Well, we are in the 21st Century so I can understand you wish

to

abandon the empiricism of Lee Love and apply micro
technology to your
work.
But before going further, I would like to know what you are
talking
about when you use the term "Heat Work", or is it
"Heatwork" when you
say <<then - in accordance with "thee literature" - it's
"possible" to apply
the same amount of heatwork using different "firing profiles"
(firing
schedules).>>>
I am not sure what other people think but it seems to me that
a
Pyrometric Cone tells us something of the calorific value of the
mass
of fuel (or kW Hours of electricity) employed and the time
span in
which they are used.
Other than that "Heatwork" is a tautology.
Best regards,
Ivor Lewis.
Who has constructed a simple preliminary formula, as a
"Thought
Experiment", which will do the trick ! !
Redhill,
S. Australia.

Jim Murphy on tue 3 aug 04

on 8/2/04 9:30 PM, Ivor and Olive Lewis at
iandol@WESTNET.COM.AU wrote:

<< But before going further, I would like to know what you
are talking
<< about when you use the term "Heat Work", or is it
"Heatwork" when you
<< say <<<< then - in accordance with "thee literature" - it's
"possible" to apply
<< the same amount of heatwork using different "firing
profiles" (firing
<< schedules). >>>

Hi Ivor,

"Heat Work" or "Heatwork" ??? ... you know ...
HEATWORK!

I'll be wise here - simply drop the semantics [for now] - say it's "a
concept" and defer to time-varying temperature changes: (a) "applied" by a
kiln; and (b) "experienced" by ceramic ware, i.e., fired results. [Note -
(b) is readily observed AFTER each firing; (a) is NOT so readily observed.]

<< ... it seems to me that a Pyrometric Cone tells us something of the
calorific value of the mass
<< of fuel (or kW Hours of electricity) employed and the time span in which
they are used.
<< Other than that "Heatwork" is a tautology. >>

Ivor, cone-bending "behavior" is affected by many things (heating rate,
cooling rate, etc.) and ["the kicker"] cone-bending occurs, normally, only
over the last 90-120 minutes of firing. [That's alot of missing temp vs.
time information over a 12- 16 hour firing.] Me thinks NOT all critical
time-varying temperature changes ["applied" or "experienced"] occur during
just those last 90-120 minutes.

So, I hear there's KISS software - available for my fancy-smancy digital
controller - that'll be able to plot a temperature vs. time "curve" from
data points generated from any firing profile I decide to enter into my
kiln's controller.

These plotted firing profile "curves" mathematically represent

the recorded
time-varying temperature changes "applied" by the kiln for the complete
[12-16 hour] firing [for a given load of ware].

Tautology aside - for my own test purposes - I'll rename the curve - a
"heatwork curve". [mathematically representing the recorded time-varying
temperature changes "applied" by the kiln for a given load of ware.]

I'll use these "heatwork curves", along with Cones or Bullers Rings, to
develop new "facts" through experimentation and observation.

Best wishes,

Jim Murphy